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### A119 Non-Linear Systems Theory and Its Application to the Assessment of Postmortem Interval

*Charles C. Boyd, PhD\**, Radford University, Dept of Anthropological Science, Radford, VA 24142; *William W. Baden, PhD*, Indiana University-Purdue University Fort Wayne, 2101 E Coliseum Boulevard, Fort Wayne, IN 46805; and *Donna C. Boyd, PhD*, Radford University, Forensic Science Institute, PO Box 6939, Radford, VA 24142

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After attending this presentation, attendees will understand the application of non-linear systems theory and computer simulation to interpreting and resolving the complex, multivariate problem of determining Postmortem Interval (PMI).

This presentation will impact the forensic science community by demonstrating the application of a non-Newtonian scientific model — non-linear systems theory — to forensic interpretations involving the interaction of multiple human and non-human variables.

Since Dr. William Bass' establishment of the "Body Farm" in 1981, a plethora of decomposition studies have emerged from this and other decay facilities with a goal of developing a more complete understanding of PMI through experimentation and actualistic study. These studies have identified a multitude of variables affecting PMI. In spite of these studies, no overall development of precise region-specific PMI models has been proposed.

The goal of this presentation is to explore the utility of non-linear systems theory and computer simulation in enhancing forensic anthropologists' ability to define PMI. Non-linear systems refer to environments with multiple variables, the interaction of which can produce more complex and unforeseen results. Non-linear systems theory is focused on how those systems are understood and analyzed. It is an ideal theoretical model to use for assessment of PMI, given the large number of interacting variables.

Historical contingency (i.e., the effects of unique or random events) and the impact of agents (both human and non-human) are given consideration in non-linear systems theory. This is important, since such events and agents may not produce patterned behavior but would still have considerable impact on the creation of the forensic scene and its interpretation.

Non-linear systems theory is quite different from the traditional reductionist scientific paradigm in that it does not isolate variables for testing but instead focuses on the results of their interaction. One important method often used in non-linear systems analysis is computer simulation which can explicate past events through the analysis of the interaction of a number of variables. Such analyses can also examine the temporal sequence of events by revealing the emergent (new and/or unique) properties periodically resulting from variable interaction. By recording environmental variables for forensic cases and experimental settings and using these in simulation studies, region-specific models for PMI can be developed which can delineate the temporal sequence of decomposition. These models may then be applied to the interpretation of new cases. The application of non-linear systems theory can, therefore, stimulate a new understanding of the PMI for forensic anthropologists and improve future interpretation of this complex problem.

To illustrate the application of this theory to PMI interpretation, a pilot study involving 20 stillborn pigs placed in different environments and examined over a period of 50 days during late summer is presented. Variables examined include pig weight, microenvironment (indoor/outdoor), degree of insect infestation, ambient temperature, and rainfall. A decomposition scale designated the degree of decay at different intervals. Non-linear simulation showed that decay rates varied between outdoor and indoor specimens. Outdoor specimens decomposed more rapidly and at a higher rate during the first five days; subsequent to this, outdoor and indoor decay rates stabilized and were comparable. This simulation created a model for decay rates of specimens over time and explained the stages of decay in relation to the variables noted above, with cumulative temperature being the most significant variable. To calculate PMI, decomposition score is matched to a value for cumulative temperature, then compared to available climate data.

Previous researchers have considered forensic anthropology to be non-theoretical or burdened with so many complex variables that it cannot be "scientific" in its interpretations. Non-linear systems theory can mitigate these problems by providing a broader definition of scientific theory and a methodology (simulation) whereby multiple variables can be examined in a systematic manner. It also can provide the theoretical and methodological tools to develop regional models for PMI. Non-linear systems theory holds the promise of honoring Dr. Bass' original research goal of reaching a more informed understanding of postmortem interval.

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#### Non-Linear Systems Theory, Computer Simulation, Postmortem Interval